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There is ample evidence today that acidity resulting from manufacturing processes is the principal cause of paper deterioration. The significance of this discovery is that purchasers can avoid paper manufactured in such a way as to be auto-destructive. This investigation explores the collective use of color spot tests to distinguish stable from unstable book and record papers currently being manufactured in the United States. The value of this type of testing is derived from its ability to separate quickly good from poor quality paper from the standpoint of useful longevity. These test results are qualitative, not quantitative, in nature. Thus, for example, while the acidity spot test will indicate the presence of acidity, it will not determine the exact amount. The spot tests for groundwood, acidity, alum and rosin can be applied to papers quickly by anyone without special equipment or training, with due caution in regard to handling the chemicals and interpreting the results. These tests only require small areas of a paper sheet, thus eliminating damage to large quantities of paper. A summary of instructions for using these tests is given. (Author/RM)

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Permanence/Durability of the Book—VI

Spot Testing for Unstable Modern Book and Record Papers

W. J. BARROW RESEARCH LABORATORY, INC.

LI 001601

Permanence/Durability of the Book—VI

Spot Testing for Unstable Modern Book and Record Papers

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I. Introduction

The merits of paper as a record material have made a place for it in the affairs of mankind. Concern for its lasting qualities, however, has justified quantities of research in the field of paper permanence and durability. Nearly five hundred studies are recorded in the technical literature for the 80 year period 1884-1964 alone.[1, 2]

The custodian of paper records—librarian, archivist, scholar, or just someone who has kept an old newspaper clipping—is only too aware of paper deterioration. But there is a paradox here too—side by side with rapidly deteriorating records are others of equal age which appear white and strong as though new. Why is this? The answers are just being found.

Over the years various agents have been blamed for deterioration of paper: illuminating gas, polluted industrial atmosphere, the actinic effects of light, bleaching agents, the substitution of wood and grass fiber for rags, etc.

Now, though, there is ample evidence that acidity resulting from manufacturing processes is the principal cause of paper deterioration. The significance of this discovery is that purchasers can avoid paper manufactured in such a way as to be auto-destructive.[3]

It is not necessary to distrust all paper today. A well-authenticated laboratory technique simulates in hours or days the effects of many years of natural aging, thus distinguishing the lasting qualities of one paper from those of another.

This accelerated (heat) aging test, developed by the United States Bureau of Standards and others, and adapted by this laboratory, compares physical characteristics (principally fold and tear) of a paper before and after oven aging for a number of days.[4]

Thorough laboratory testing to quantify the stability of a paper requires expensive equipment, a great deal of time, a substantial sample of the paper, and experienced personnel.

Often the custodian or user of paper records needs to recognize papers having prospects of lasting quality from others of less stability so that he can (a) take the measures necessary

for stabilization, or (b) avoid using low quality paper in situations in which a stable paper is required.

However, the layman is at a disadvantage in distinguishing paper differences since analysis by visual examination alone is impossible. The tests studied in this report have been developed with the intention of helping to solve this problem.

While they are not complete substitutes for laboratory analysis, these spot tests can quickly determine whether certain constituents are present which will cause a fast rate of deterioration. These constituents which have consistently been found associated with instability in paper are groundwood, high acidity, and alum-rosin size.[5]

It is this laboratory's hope that people will take advantage of this information in their attempt to purchase or use paper of lasting quality.

This investigation was sponsored by the Council on Library Resources, Inc., which is in turn funded by the Ford Foundation.

WILLIAM J. BARROW

Richmond, Virginia
August 1967

The investigation reported here was completed by the Laboratory during Mr. Barrow's life-time and the report was undergoing revision at the time of his death, August 25, 1967. They remain his work.

R. N. DUPUIS

Richmond, July 1968

II. Purpose and Testing Procedures

On the basis of work performed in this laboratory and elsewhere it is believed that paper having the following characteristics may be expected to possess sufficient stability to qualify it for library/archival use:

a) Freedom from groundwood.[5, 6]
b) A pH of 6.5+.[3, 5, 7]
c) Freedom from alum.[5, 8, 9]
d) Freedom from alum-rosin size.[5, 8, 9, 10]

This investigation explores the collective use of color spot tests to distinguish stable from unstable book and record papers currently being manufactured in the United States. Spot tests are widely accepted in laboratories for many kinds of quick qualitative analyses.

The value of this type of testing is derived from its ability to quickly separate good from poor quality paper from the standpoint of useful longevity. These test results are qualitative, not quantitative, in nature. Therefore, for example, while the acidity spot test will indicate the presence of acidity, it will not determine the exact amount.

Four different kinds of paper were used in this study. Samples of 125 writing papers widely used throughout the United States were tested. These were chosen at random from new sheets as well as from letters received in this laboratory from various individuals, universities, historical societies, corporations, etc., during the past two years.

One hundred eight uncoated book papers were taken from fiction and non-fiction books published in the United States since 1960 (the majority since 1964) and from unprinted sheets.

Sixty-three coated book papers came from similar publications of the past four years and from new sheets.

Twenty magazine papers were taken from representatives of both the popular periodicals and from technical journals. Two of these were uncoated; the rest were coated.

Specimens were tested for pH (a scientific term for expressing acidity or alkalinity; pH 1 is extremely acid, pH 7 is neutral, and pH 14 is extremely alkaline) by the cold extraction method.[4] In addition, spot (color) tests for groundwood,

acidity, alum and rosin were administered. All the test results are listed in Tables 1-4.

From the total of 316 papers in the four groups, 227 or 72% showed a pH below pH 6.5, the lower limit for a stable, relatively non-acid paper. Following are the number and percentage of books by group having a pH 6.5 or lower (too acid): writing—94 (75%) of the 125 papers; uncoated book papers—87 (81%) of the 108 papers; coated book papers—39 (62%) of the 63 papers; and magazine papers—7 (35%) of the 20 papers.

From the aforementioned figures, it is obvious that paper manufacturers still pay little heed to the much publicized warnings concerning the presence of acidity in paper.

For purchasers who desire stability and longevity in record papers, the collective spot test check is a sufficiently accurate method to discriminate between good and bad paper.

With extremely few exceptions, most of which can be accounted for, the spot test results are consistent throughout the different types of paper tested. It was surprising to find that most of the book papers tested had pH values either in the decidedly acid range (below pH 6.0) or in the near neutral or alkaline range (above pH 7.0). This was not true in the writing papers. A number of these were in the pH 6.0 to 6.7 range and therefore in the acid test "twilight zone" in which the color reaction of the acidity spot test is ambiguous, as described below.

In testing the coated papers, it is necessary to split the paper and test the interior as well as the exterior, since the coating applied can disguise the characteristics of the paper found within. Splitting is accomplished by firmly covering both sides of a corner of the sheet with pressure sensitive tape, and pulling apart.

Spot Testing Procedures

Test for groundwood. The groundwood papermaking process mechanically reduces wood to fiber with little or no chemical processing to remove deteriorative components (such as lignin). It is generally accepted that papers containing groundwood are unstable; they quickly discolor and become brittle on exposure to light and air. If the groundwood content is high

(as in modern newsprint), the life expectancy of the paper is only 10-20 years, and somewhat longer if an alkaline filler has been used (as in modern magazine papers).[5]

Accordingly, the groundwood test should be run first. If groundwood is found present in the paper, it may be classified as unstable, and none of the other tests need be run.

This spot test reagent is a solution of one gram phloroglucinol in 50 ml. methyl alcohol and 50 ml. hydrochloric acid. This test is accepted as part of regular laboratory testing practice.[11]

A thin line of the solution is spread on uninked portions of the paper with a medicine dropper or glass rod applicator. If it remains colorless there is no groundwood present. It will turn a magenta—a deep purplish red—if groundwood is present. Microscopic analysis will determine the percentage of groundwood. The color reactions are immediate; there is no need to wait for the spot to dry.

Care should be taken not to run any other spot tests on the sheet within at least an inch of this test. A visible feathering and an invisible spreading of the chemical affects other tests, invalidating their results.

The testing solution yellows with age, causing different color reactions; therefore, fresh solution should be made periodically.

Test for acidity. This spot test is intended to determine whether the amount of acidity present is acceptable or unacceptable for good stability in a paper. The testing solution (referred to here as chlorophenol) consists of 0.420 grams of Chlorophenol Red in 1000 ml. of distilled water.[12]

With a medicine dropper or glass rod applicator, a thin line of chlorophenol solution is spread on uninked portions of the paper in an even line about an inch long. If the line or spot turns a decided yellow, strong acid (pH 6.0 and below) is present. (See comparision with pH meter results in Tables 1, 2, and 3.) If the spot turns a definite purple, either a near neutral or an alkaline condition (pH 6.6 and above) exists in the paper. The spot should be allowed to dry before results are determined.

A chlorophenol solution is yellow when acidic, and purple when alkaline. Obviously, when the solution is brought near

neutrality by adding acid or alkali, the color changes to a shade between these two extremes. This change is seldom sharp, but may go from yellow through yellow-green, green, or grayish in the range pH 6.0 to 6.7. Certain impurities in the paper may contribute to these unsharp colors. This is of little practical importance, however, since in almost every case we have observed, the color of the spot test was either definitely yellow, i.e., acidic and undesirable, or definitely purple, i.e., alkaline and desirable.

Thus, as seen below, a small percentage of tests may give equivocal results. There is a built-in safety factor, however, in that four different spot tests are described in this report from which an unequivocal result can be obtained in almost every case. Where the spot tests give conflicting or equivocal results, they should not be relied upon. If the importance of the inquiry justifies it, laboratory tests using a pH meter and even if necessary other diagnostic instruments should be used.

Test for alum. This laboratory adapted the aluminon test for the aluminum ion for use with paper.[13, 14, 15] The testing solution is composed of one gram of aluminon per liter of distilled water.

The test is run by spreading a thin line of the solution on uninked portions of the paper with a medicine dropper or a glass rod applicator. When there is no alum present in the paper, the spot will remain a very faint pink (the color of the solution) or turn colorless. It will turn a bright to deep pink if alum is present. More than the other tests, this requires a discriminating eye to judge the shade of difference in color which indicates a positive or negative reaction. Results should be determined after the spot has dried.

Aluminon indicates the presence of the aluminum ion, which in turn indicates, in almost all cases, the presence of alum (aluminum sulfate) resulting from the use of alum-rosin size or from alum in other manufacturing processes. Aluminon was evaluated as a spot test for the aluminum ion by treating papers with various compounds which are likely to be found in paper. It reacted to only one—iron—but with a color (a deep purple) so different that there is no danger of confusion. Spot testing older papers has occasionally resulted in a pink-

purplish reaction, probably indicating the presence of iron and aluminum. This result has not occurred in modern books tested here.

The test was developed recently after much of the paper testing had been completed. When possible, it was added to the test data presented here, but in some cases this was impossible since the papers had been discarded.

Test for rosin. As shown in a recent study by this laboratory, alum-rosin size gained almost universal acceptance as a sizing agent (to make paper less absorbent) in book paper manufacturing in the United States by 1870. The rosin test indicates the presence of this deleterious sizing ingredient.

The Raspail test [16] for rosin is run by putting a drop of sugar water (a nearly saturated solution) on uninked portions of paper with a medicine dropper. The excess liquid is wiped off with filter paper or absorbent cotton. Onto this spot a circle of sulfuric acid (96.6% concentration) is spread with a medicine dropper. This must be applied with utmost caution, since there is danger of burning skin or eating holes through clothing.

If rosin is present, the spot will turn a decided pink raspberry color. If there is no rosin, the spot will remain colorless or turn a brownish color. The rosin test will char the paper if there is groundwood present. The color reaction is visible immediately.

This test is relatively dangerous to the person or work area when used without benefit of laboratory or protective coat and without caution in the use of sulfuric acid. The test for aluminum is thus recommended as safer and more direct, since alum is the ultimate source of acidity.

NOTE: Approximately 100 kits containing one ounce each of the alum, acidity and groundwood reagents, in bottles with applicators, are available on a first-come-first-served basis, as long as the supply lasts.

III. Analysis of Results

On the basis of the preceding tests, general conclusions can be made regarding the stability or instability of papers currently manufactured in the United States.

Because of the limitations which can be expected of qualitative spot tests such as these, questions brought about by deviations should be resolved by laboratory analysis.

The groundwood test showed that three coated book papers (Table 3, Specimen Nos. 4, 5 and 6) and 16 magazine papers of which all but 1 were coated (Table 4) contained groundwood and therefore can be immediately classed as unstable. Further testing can be eliminated. This classification will remain true for chemimechanical and semichemical pulps to which the groundwood test also reacts.

The importance of the chlorophenol test for acidity is the ability to distinguish acid from alkaline papers. In 88% of the sheets tested, the result was clear cut. Papers with pH below 6.0 consistently reacted with a yellow color; papers with a pH of 6.7 and above reacted with a purple color.

Of the 39 samples (12% of the total) which were not clear cut yellow or purple, 7% fell into the expected color change-over range (twilight zone). The remaining 5% of the chlorophenol test results were unexpected—they did not agree with the pH test result. It is assumed that these papers contained impurities which affected the color obtained.

It can be seen in the tables that most of the papers in the sample reacted similarly (either positively or negatively) to both the alum and the rosin test. This was to be expected since the two substances are usually used together for sizing. There were 32 papers which reacted positively to alum but negatively to rosin, and 9 papers which reacted negatively for alum but positively to rosin. From this it is seen that alum—which is the primary source of acidity in alum-rosin size—gets into paper in a significant number of cases independently of the size, and that the test for rosin, while doing little more than corroborate the findings of the test for alum when introduced in conjunction with the size, of course fails to detect the cases in which the alum occurs alone. In other words, the rosin test adds little

to our knowledge over the alum test for the purpose of predicting the stability of paper.

The alum and rosin tests are useful for corroboration of the acidity test results. In other words, if a purple reaction to the acid test is strengthened by negative reactions to the alum and rosin tests, it may indicate alkalinity/mild acidity, but should be rejected if evidence of alum-rosin exists (by a positive reaction to these tests).

IV. Summary and Conclusions

The spot tests for groundwood, acidity, alum and rosin can be applied to papers quickly by anyone without special equipment or training, with due caution in regard to handling the chemicals and interpreting the results. These tests only require small areas of a paper sheet, thus eliminating damage to large quantities of paper.

Because of the acid reagents used in performing the groundwood and rosin tests, these tests must not be run on paper within a book. The coloration which may be produced by the acidity test and the alum test may be considered undesirable in a book. Samples should therefore be removed from the book before testing.

A total of four square inches of paper will be adequate for these tests. The samples need not be from the same page as long as all pages are of the same kind of paper (for example pages with illustrations may differ from other pages.) Only paper uninked on either side should be used. A margin of at least 1/8" should be cut and thrown away from the edges of the pages because of possible contamination from handling or exposure to deleterious atmosphere. As indicated below, certain spot tests must be kept an inch apart, which will have some effect on the size and shape of the samples cut for testing.

A summary of instructions may be useful to people who wish to use the spot test procedure. (Note: Coated papers must be split and both the interior and the exterior should be tested, as described on page 10).

1. Groundwood test.

   Testing procedure: spread thin line of solution on uninked portion of paper. Analyze immediately. Do not run other tests within an inch of this one.

   Results: A. If positive (magenta), reject the paper as unstable.

   B. If negative (colorless), accept the paper conditionally and run next test.

2. Acidity test.

Testing procedure: spread thin line of solution on uninked portion of paper. Wait for spot to dry.

Results: A. If yellow or other various hues such as yellow-green, etc., discard the paper as unstable. There is acid somewhere. Aluminon and rosin tests can be run to check for alum and rosin as possible sources of acidity.

B. If purple, accept the paper conditionally. Run aluminon and rosin tests to reinforce the decision.

3. Alum test.

Testing procedure: spread thin line of solution on uninked portion of paper. Wait for spot to dry.

Results: A. If positive (bright pink), reject the paper as lacking assurance of stability.

B. If negative (colorless or very faint pink), accept the paper.

4. Rosin test.

Testing procedure: Put drop of sugar water on uninked portion of paper and wipe off excess with filter paper. Spread sulfuric acid onto this spot. Analyze immediately.

Results: A. If negative (colorless, brownish), consider as confirmation of 3B.

B. If positive (pink raspberry), consider as weakening 3B. Have laboratory tests run on the paper.

SPOT TEST COLOR CHART

GROUNDWOOD

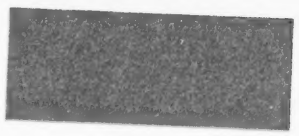
If spot is magenta groundwood is present.

If spot is cream or colorless, no groundwood is present.

ACIDITY

If spot is yellow, the paper is decidedly acid (less than pH 6.0).

An in-between color (green, gray, gray-green, yellow-green) indicates mild acidity (pH 6.0-6.7).



If spot is purple, the paper is near-neutral or alkaline (pH 6.7+).

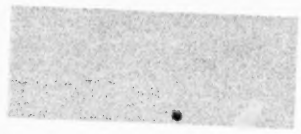
ALUM

If spot remains faint pink or turns colorless, no alum is present.

If spot turns bright pink, alum is present.

ROSIN

If spot turns brownish-black, or remains colorless, or gray, no rosin is present.



If spot turns faint to bright pink, rosin is present.

TABLE 1. Results of tests for pH (cold extraction) and of spot tests for acidity, alum, rosin, and groundwood on 125 bond and ledger papers.

Specimen No.	pH	Acidity	Alum	Rosin	Ground-wood
1	4.7	yellow-dark	-	P	N
2	4.7	yellow	-	P	N
3	4.7	yellow	-	P	N
4	4.8	yellow	-	P	N
5	4.9	yellow	-	P	N
6	4.9	yellow	-	P	N
7	5.0	yellow	-	P	N
8	5.0	yellow	-	P	N
9	5.0	yellow	-	P	N
10	5.0	yellow	-	P	N
11	5.0	yellow	-	P	N
12	5.1	yellow-green	-	P	N
13	5.1	yellow	-	P	N
14	5.1	yellow	-	P	N
15	5.1	yellow	-	N	N
16	5.1	yellow	-	?	?
17	5.2	yellow	-	P	N
18	5.2	yellow	-	P	N
19	5.2	yellow	P	P	N
125	5.2	yellow	-	P	N
20	5.3	yellow	-	P	N
21	5.3	yellow	-	P	N
22	5.3	yellow	-	P	N
23	5.3	yellow	-	P	N
24	5.3	yellow	P	P	N
25	5.3	yellow	-	P	N
26	5.3	yellow	-	P	N
27	5.4	yellow	-	P	N
28	5.4	yellow	-	P	N
29	5.4	yellow	P	P	N
30	5.4	yellow	P	P	N
31	5.4	yellow	P	P	N
32	5.4	yellow-green	P	P	N
33	5.4	yellow	P	P	N
34	5.4	yellow	-	N	N
35	5.5	yellow	-	P	N
36	5.5	yellow	-	P	N
37	5.5	yellow	-	P	N
38	5.5	yellow	P	P	N
39	5.5	yellow	P	P	N
40	5.5	yellow	P	P	N
41	5.6	yellow-dark	-	P	N
42	5.6	yellow	-	P	N

Abbreviations used in tables: P = positive, N = negative, - = no test made, and sl. = slightly.

TABLE 1 (con't.)

Specimen No.	pH	Acidity	Alum	Rosin	Ground-wood
43	5.6	yellow	P	P	N
44	5.6	yellow	P	P	N
45	5.6	yellow	P	P	N
46	5.6	yellow	P	P	N
47	5.7	yellow-dark	-	P	N
48	5.7	yellow-dark	-	P	N
49	5.7	yellow	P	P	N
50	5.7	yellow	P	P	N
51	5.7	yellow	P	P	N
52	5.7	yellow-green	P	P	N
53	5.7	green-gray	N	P	N
54	5.7	yellow	-	P	N
55	5.7	yellow	-	P	N
56	5.7	yellow	-	P	N
57	5.7	yellow	-	P	N
58	5.7	yellow	-	P	N
59	5.8	yellow-green	N	P	N
60	5.8	yellow	-	P	N
61	5.9	yellow-dark	-	P	N
62	5.9	yellow	P	P	N
63	5.9	yellow	P	P	N
64	5.9	yellow	P	P	N
65	5.9	yellow	-	P	N
66	6.0	colorless	-	P	N
67	6.0	gray	-	P	N
68	6.0	yellow-dark	-	P	N
69	6.0	yellow	P	P	N
70	6.0	yellow-green	P	P	N
71	6.0	yellow	P	P	N
72	6.0	yellow	P	P	N
73	6.0	yellow-green	P	P	N
74	6.1	purple	-	P	N
75	6.1	gray	-	P	N
76	6.1	yellow	P	P	N
77	6.1	green-gray	P	P	N
78	6.1	yellow	P	P	N
79	6.1	yellow-green	P	P	N
80	6.1	yellow	P	P	N
81	6.1	yellow-green	P	P	N
82	6.1	yellow	P	P	N
83	6.1	yellow-green	N	P	N
84	6.1	yellow-green	P	P	N
85	6.2	gray	-	P	N
86	6.2	yellow	P	P	N
87	6.2	yellow	P	P	N
88	6.2	gray	P	P	N
89	6.2	yellow-green-gray	N	P	N

TABLE 1 (con't.)

Specimen No.	pH	Acidity	Alum	Rosin	Ground-wood
90	6.2	yellow-gray	–	P	N
91	6.3	yellow	P	P	N
92	6.4	gray	P	P	N
93	6.4	purple	–	P	N
94	6.5	yellow-green	P	P	N
95	6.6	purple	–	N	N
96	6.6	purple	–	N	N
97	6.7	purple	–	N	N
98	6.7	yellow-green	N	P	N
99	6.7	gray-green	N	P	N
100	6.7	purple	–	N	N
101	6.8	purple	–	N	N
102	6.9	purple	–	N	N
103	7.0	purple	–	N	N
104	7.0	gray-green	N	P	N
105	7.0	yellow-green	N	P	N
106	7.2	purple	–	N	N
107	7.5	purple	–	N	N
108	7.6	purple	–	N	N
109	7.7	purple	–	N	N
110	7.7	purple-gray	N	N	N
111	8.0	purple	–	N	N
112	8.1	purple	–	N	N
113	8.4	purple	–	N	N
114	8.8	purple	–	N	N
115	8.8	purple	N	N	N
116	8.8	purple	N	N	N
117	8.9	purple	–	N	N
118	8.9	purple	N	N	N
119	9.0	purple	–	N	N
120	9.0	purple	–	N	N
121	9.1	purple	–	N	N
122	9.2	purple	N	N	N
123	9.3	purple	N	N	N
124	9.3	purple	N	N	N

TABLE 2 - Results of tests for pH (cold extraction) and of spot tests for acidity, alum, rosin, and groundwood on 108 uncoated book papers.

Specimen No.	pH	Acidity	Alum	Rosin	Ground-wood
1	4.3	yellow	P	P	N
2	4.3	yellow	P	P	N
3	4.5	yellow	P	P	N
74	4.5	yellow	P	P	N

TABLE 2 (con't.)

Specimen No.	pH	Acidity	Alum	Rosin	Ground-wood
97	4.6	yellow	P	P	N
43	4.7	yellow	P	P	N
68	4.7	yellow	P	N	N
59	4.7	yellow	P	N	N
47	4.8	yellow	P	P	N
102	4.8	yellow	-	P	N
90	4.8	yellow	P	P	N
87	4.8	yellow	P	P	N
82	4.8	yellow	P	P	N
26	4.8	yellow	P	P	N
4	4.8	yellow	P	P	N
5	4.8	yellow	P	N	N
80	4.8	yellow	P	N	N
44	4.8	yellow	P	N	N
95	4.8	green	P	N	N
7	4.9	yellow	P	P	N
6	4.9	yellow	P	P	N
62	4.9	yellow	P	P	N
99	4.9	yellow	P	P	N
96	4.9	yellow	P	N	N
61	4.9	yellow	P	N	N
69	4.9	yellow	P	N	N
98	5.0	yellow	P	P	N
93	5.0	yellow	P	P	N
75	5.0	yellow	P	P	N
46	5.0	yellow	P	P	N
8	5.0	yellow	P	P	N
94	5.0	yellow	P	N	N
10	5.1	yellow	P	P	N
30	5.1	yellow	P	P	N
31	5.1	yellow	P	P	N
91	5.1	yellow	P	P	N
92	5.1	yellow	P	P	N
9	5.1	yellow	P	N	N
51	5.1	yellow	P	P	N
57	5.1	yellow	P	N	N
58	5.2	yellow	P	P	N
25	5.2	yellow	P	P	N
49	5.2	yellow-green	P	P	N
89	5.2	yellow	P	N	N
70	5.2	yellow-green	P	N	N
67	5.2	yellow	P	N	N
45	5.2	yellow	P	N	N
41	5.2	yellow	P	N	N
42	5.2	yellow	P	N	N
83	5.3	yellow	P	P	N
60	5.3	yellow	P	N	N
53	5.3	yellow	P	P	N

TABLE 2 (con't.)

Specimen No.	pH	Acidity	Alum	Rosin	Ground-wood
55	5.3	yellow	P	P	N
29	5.3	yellow	P	P	N
11	5.3	yellow	P	P	N
64	5.3	yellow	P	N	N
40	5.3	yellow	P	N	N
86	5.3	yellow-green	P	N	N
56	5.4	yellow	P	P	N
37	5.4	yellow	P	P	N
72	5.4	yellow	P	P	N
85	5.4	yellow	P	P	N
78	5.4	yellow	P	N	N
65	5.4	yellow	P	N	N
84	5.4	yellow-green	P	N	N
103	5.5	yellow	-	P	N
39	5.5	yellow	P	P	N
12	5.5	yellow	P	P	N
79	5.5	yellow	P	N	N
54	5.5	yellow	P	N	N
81	5.6	yellow-gray	P	N	N
14	5.7	yellow	P	P	N
101	5.7	yellow	P	N	N
13	5.7	sl.purple	P	P	N
15	5.8	yellow	P	P	N
16	5.8	yellow	-	P	N
32	5.8	yellow	P	P	N
66	5.8	yellow-green	P	N	N
104	6.0	yellow	P	P	N
38	6.1	yellow	P	P	N
17	6.1	yellow-dark	P	P	N
108	6.1	yellow-gray	-	P	N
107	6.1	yellow-dark	-	N	N
18	6.2	yellow-dark	P	P	N
105	6.3	yellow	-	N	N
71	6.3	yellow-green	P	N	N
106	6.4	yellow	-	N	N
27	7.5	purple	N	N	N
19	7.9	purple	N	N	N
33	7.9	purple	N	N	N
35	8.0	purple	N	N	N
34	8.1	purple	N	N	N
76	8.1	purple	N	N	N
77	8.2	purple	N	N	N
100	8.2	purple	N	N	N
20	8.2	purple	N	N	N
73	8.3	gray	N	N	N
36	8.3	purple	N	N	N
21	8.4	purple	N	N	N
63	8.4	purple	N	N	N

TABLE 2 (con't.)

Specimen No.	pH	Acidity	Alum	Rosin	Ground-wood
88	8.5	purple	N	N	N
50	8.5	purple	N	N	N
22	8.6	purple	N	N	N
23	8.6	purple	-	N	N
48	8.7	purple	N	N	N
52	8.7	purple	N	N	N
28	9.3	purple	N	N	N
24	9.5	purple	N	N	N

TABLE 3 - Results of tests for pH (cold extraction) and of spot tests for acidity, alum, rosin, and groundwood on 63 coated book papers.

Specimen No.	pH	Acidity	Alum	Rosin	Ground-wood
49	4.7	yellow	P	P	N
27	4.9	yellow	P	P	N
42	5.0	yellow	P	P	N
39	5.0	yellow	P	P	N
30	5.0	yellow	P	P	N
53	5.0	yellow	P	P	N
63	5.1	yellow	P	P	N
56	5.1	yellow	P	P	N
48	5.1	yellow	P	P	N
50	5.1	yellow	P	P	N
52	5.1	yellow	P	P	N
45	5.1	yellow	P	P	N
31	5.1	yellow	P	P	N
25	5.1	yellow	P	P	N
57	5.2	yellow	P	P	N
59	5.2	yellow	P	P	N
62	5.2	yellow	P	P	N
24	5.2	yellow	P	P	N
43	5.2	yellow	P	P	N
38	5.2	yellow	P	P	N
37	5.3	yellow	P	P	N
26	5.3	yellow	P	P	N
34	5.3	yellow	P	P	N
54	5.4	yellow	P	P	N
55	5.4	yellow	P	P	N
40	5.4	yellow	P	P	N
46	5.4	yellow	P	P	N
51	5.4	yellow	P	P	N
47	5.5	yellow	P	P	N
41	5.5	yellow	P	P	N
28	5.5	yellow	P	P	N
36	5.5	yellow	P	P	N
33	5.5	yellow	P	P	N

TABLE 3 (con't.)

Specimen No.	pH	Acidity	Alum	Rosin	Ground-wood
58	5.5	yellow	P	P	N
61	5.5	yellow	P	P	N
60	5.6	yellow	P	P	N
35	5.6	yellow	P	P	N
29	5.7	yellow	P	P	N
1	6.2	yellow	N	P	N
2	6.6	yellow-green	N	N	N
3	7.0	yellow-green	N	N	N
4	7.2	purple-gray	-	?	P
5	7.4	purple-gray	-	?	P
23	7.4	purple	N	N	N
6	7.5	gray-green	-	?	P
7	7.6	green	N	N	N
44	7.7	purple	N	N	N
32	7.8	purple	N	N	N
8	8.0	purple	N	N	N
9	8.1	purple-gray	N	N	N
10	8.2	purple	-	N	N
11	8.2	purple	-	N	N
12	8.4	purple-gray	N	N	N
13	8.5	purple	N	N	N
14	8.5	purple	N	N	N
15	8.6	purple	N	N	N
16	8.7	purple	N	N	N
17	8.7	purple	N	N	N
18	8.9	purple	N	N	N
19	8.9	purple	N	N	N
20	9.0	purple	-	N	N
21	9.9	purple	-	N	N
22	9.9	purple	-	N	N

TABLE 4 - Results of tests for pH (cold extraction) and of spot tests for acidity, alum, rosin, and groundwood on 20 magazine papers. All but specimen numbers 1 and 2 were coated.

Specimen No.	pH	Acidity	Alum	Rosin	Ground-wood
1	5.1	yellow	P	P	N
2	5.4	-	-	-	P
4	5.8	-	-	-	P
19	5.9	-	-	-	P
3	6.1	yellow-gray	P	N	N
20	6.1	-	-	-	P
5	6.4	-	-	-	P
6	6.5	-	-	-	P
14	6.5	-	-	-	P
11	6.6	-	-	-	P
7	7.0	-	-	-	P

TABLE 4 (con't.)

Specimen No.	pH	Acidity	Alum	Rosin	Ground-wood
17	7.0	-	-	-	P
9	7.0	-	-	-	P
8	7.4	-	-	-	P
15	7.4	-	-	-	P
12	7.8	-	-	-	P
13	7.8	-	-	-	P
10	7.9	purple-gray	N	N	N
16	8.0	-	-	-	P
18	8.5	purple-gray	N	N	N

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